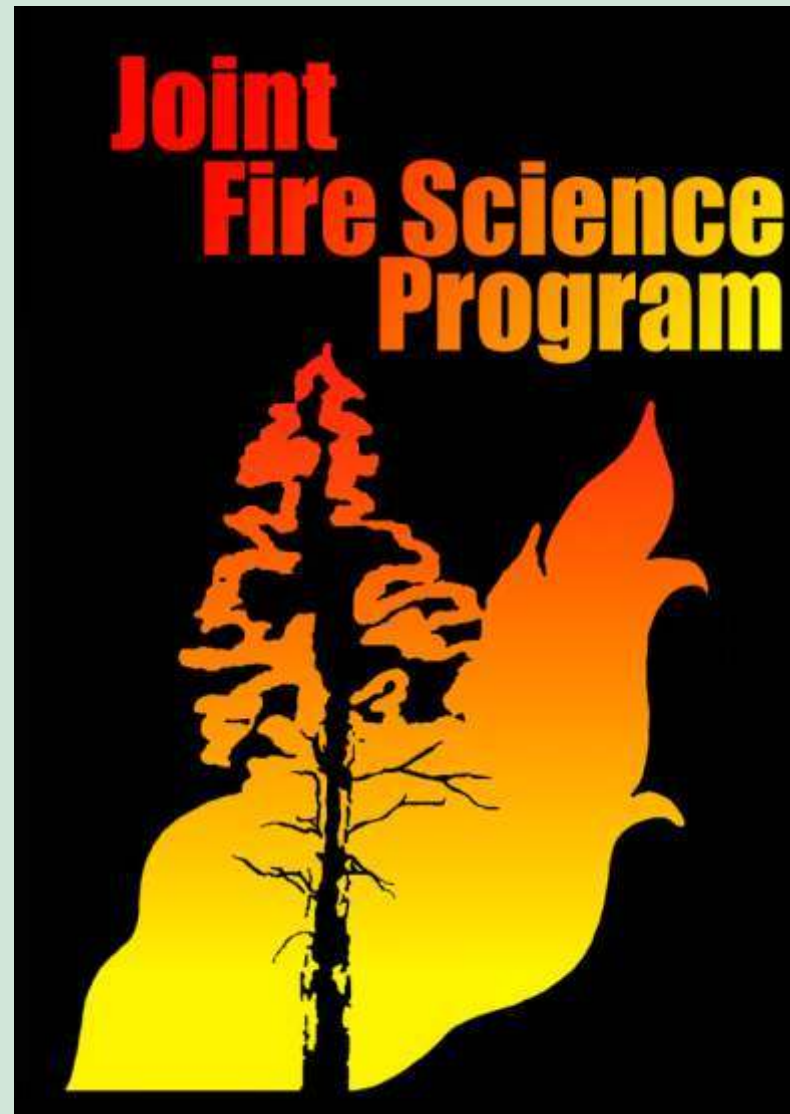


Multi-season climate synchronized widespread forest fires over four centuries (1630-2003), Northern Rocky Mountains USA



Emily K. Heyerdahl¹, Penelope Morgan², Carly E. Gibson², & James P. Riser II¹

¹USDA Forest Service
RMRS, Fire Sciences Lab, Missoula, MT

²Department of Forest Resources
University of Idaho, Moscow, ID



MOTIVATION FOR THE RESEARCH

Regionally synchronous fires, like those in the US northern Rocky Mountains in 1910, 1988, 1994, 2000 and 2003, can account for the majority of area burned in a region. During such years, the threats to people and their property are high because such fires can quickly overwhelm suppression efforts. They may also “reset” succession over large areas and thus may contribute to positive feedback whereby extensive fires become more likely. The cumulative effect of extensive fires could greatly alter regional forest carbon budgets, water and nutrient cycles, and the habitats of species of conservation concern. Understanding the complex interactions between land use, vegetation type, and climate is critical to predicting the effects of climate variability and climate change on future fire extent and severity and to help land managers in their strategic planning for ecologically and socially important regional fire years.

OBJECTIVES

- (1) identify historical and modern regionally synchronous fire years in the US Northern Rockies (Idaho and Montana west of the Continental Divide)
- (2) identify the climate forcing of these years of regionally synchronous fires
- (3) determine whether modern regional fire years burn preferentially in some forest types and whether the dominant forest type burning has changed through time

METHODS

- (1) identify regional fire years:
 - (a) historical fires (1630-1900) from fire scars in dry forests (ponderosa pine-dominated)
 - (b) modern fires (1900-2003) across a range of forest types from a digital polygon fire history
- (2) compare historical and modern fires to climate (reconstructed from tree rings for historical fire and instrumental for modern fire):
 - (a) spring temperature
 - (b) summer moisture (Palmer Drought Severity Index or precipitation)
 - (c) large-scale climate patterns that affect spring climate:
 - El Niño-Southern Oscillation
 - Pacific Decadal Oscillation
- (3) determine if climate parameters interacted in synchronizing widespread fires

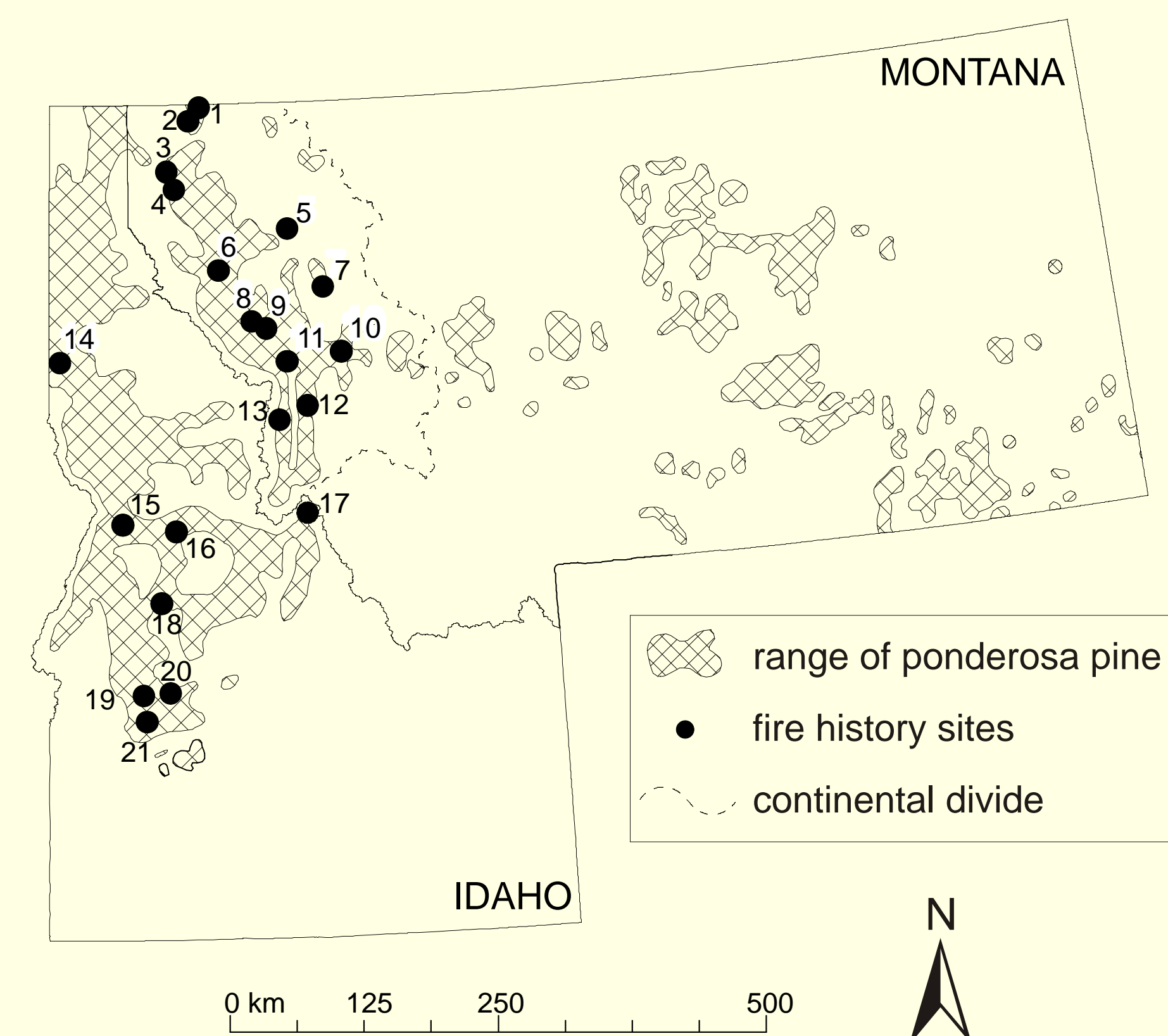


Figure 1. Historical fire: location of the 21 dry forest fire-scar sampling sites in Idaho and Montana, west of the Continental Divide. The range of ponderosa pine, the primary fire-scarred species sampled for this study, is also shown.

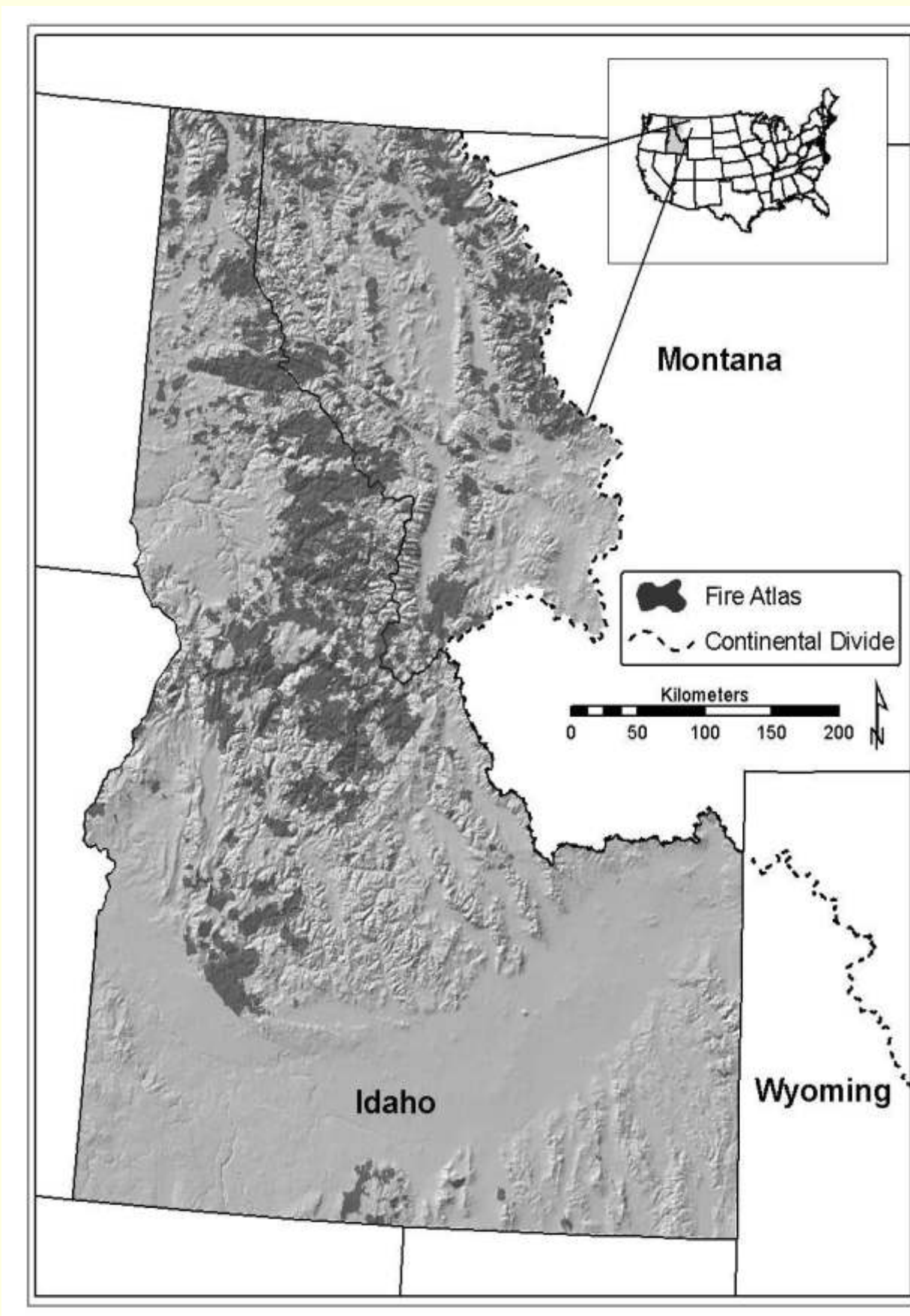


Figure 2. Modern fires: Our fire atlas is reported from 12,985,058 ha of mostly forested land on 12 national forests and 1 national park. Burned polygons (1900-2003) are shown in black against a background of elevation.

RESULTS

- (1a) We identified 29 past regional fire years (1630-1900):
 - from 9499 fire scars and fire-caused injuries on 576 trees
 - identified as years that exceeded the 90th percentile in sites with fire
- (1b) We identified 11 modern regional fire years (1900-2003, figure 3)
 - from 5,038 fires reported from nearly 13 million ha (12 national forests and 1 national park)
 - identified as years that exceeded the 90th percentile in fire extent

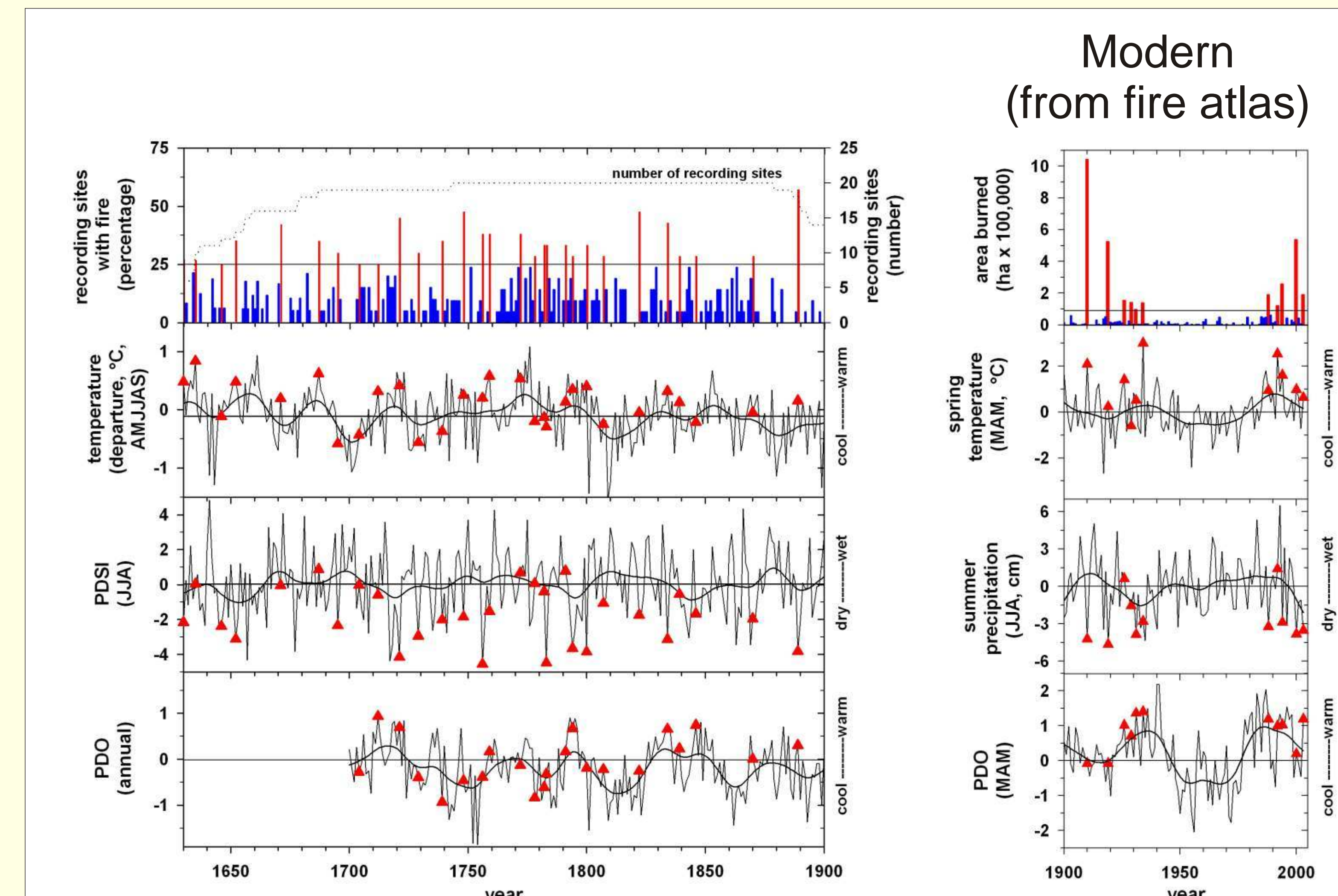


Figure 4. Historical (left) and modern (right) regional fire years were ones when springs were warm and summers were warm/dry. Regional fire years are indicated in red (bars in top plots and triangles in lower plots).

- (3) For roughly the past four centuries, regional fire years were ones of warm springs that were followed by dry summers (Figure 5).

DISCUSSION

Despite intensive land use and fire suppression during the 20th century, fires burned synchronously across diverse geographic areas and forest types when climate conditions were conducive, as they did for the prior three centuries.

The mid-20th century gap in fire followed by a late 20th-century increase has been attributed to the cumulative effects of fire suppression and other land uses, but it could also be driven, at least in part, by climate variability and/or climate change (Westerling et al. 2006). Although our data confirm the conclusions of Westerling et al. (2006) that warm springs led to regionally synchronous fires in the late 20th century, we found that the same was also true in the early 20th century and in prior centuries. We suggest that variation in fire extent during the 20th century resulted from complex interactions of climate variation, climate change, fire suppression, land use, and forest type.

Analysis of fire at points randomly sampled from the fire atlas indicates that the regional fire years identified from point records such as fire scars on trees are roughly equivalent to those we identified from fire extent in the fire atlas.

Fire atlases are a bridge between the past and present, helping us apply the lessons from fire scars and other fire proxies to the future. The collection and preservation of fire atlas records should be a priority in other regions of North America

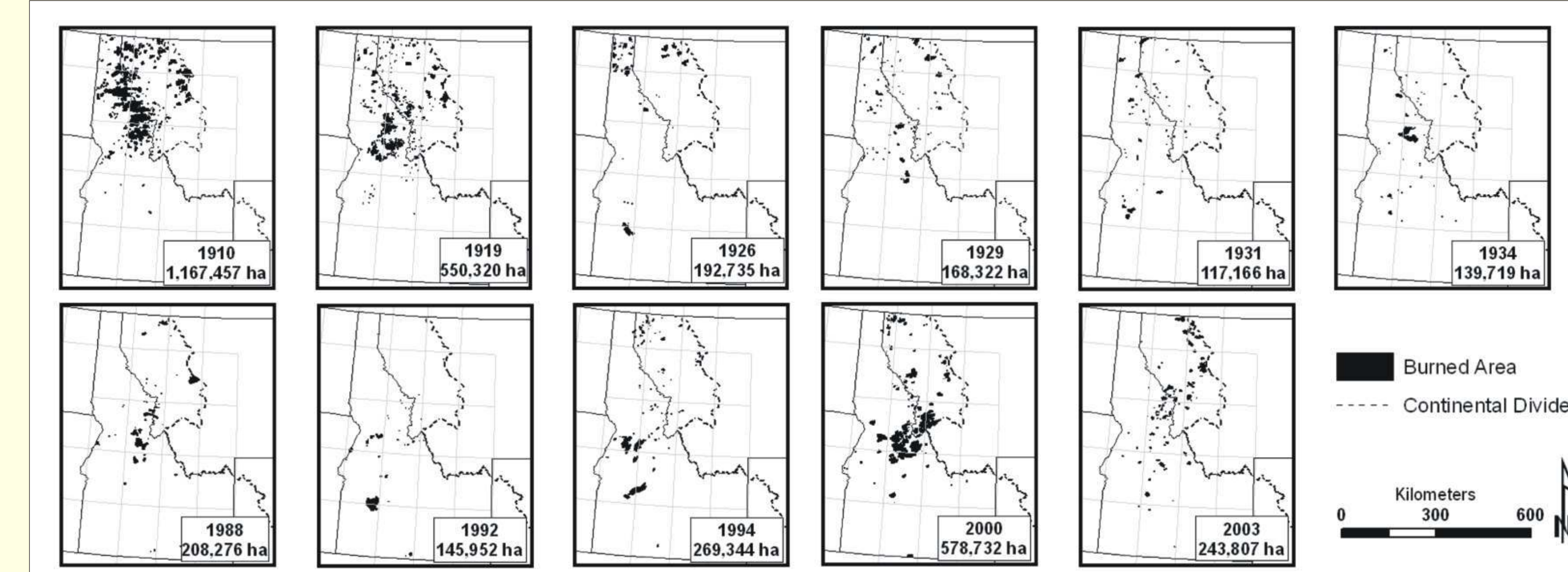


Figure 3. Modern regional fire years identified from digital polygon fire atlas.

- (2a) Spring temperature and summer moisture were strong drivers of past and modern regional fire years (figure 3, middle plots).

- (2b) The Pacific Decadal Oscillation is a strong driver of modern, but not historical, regional fire years (figure 3, bottom plots).

- (2c) El Niño-Southern Oscillation was not a significant driver of either historical or modern fires.

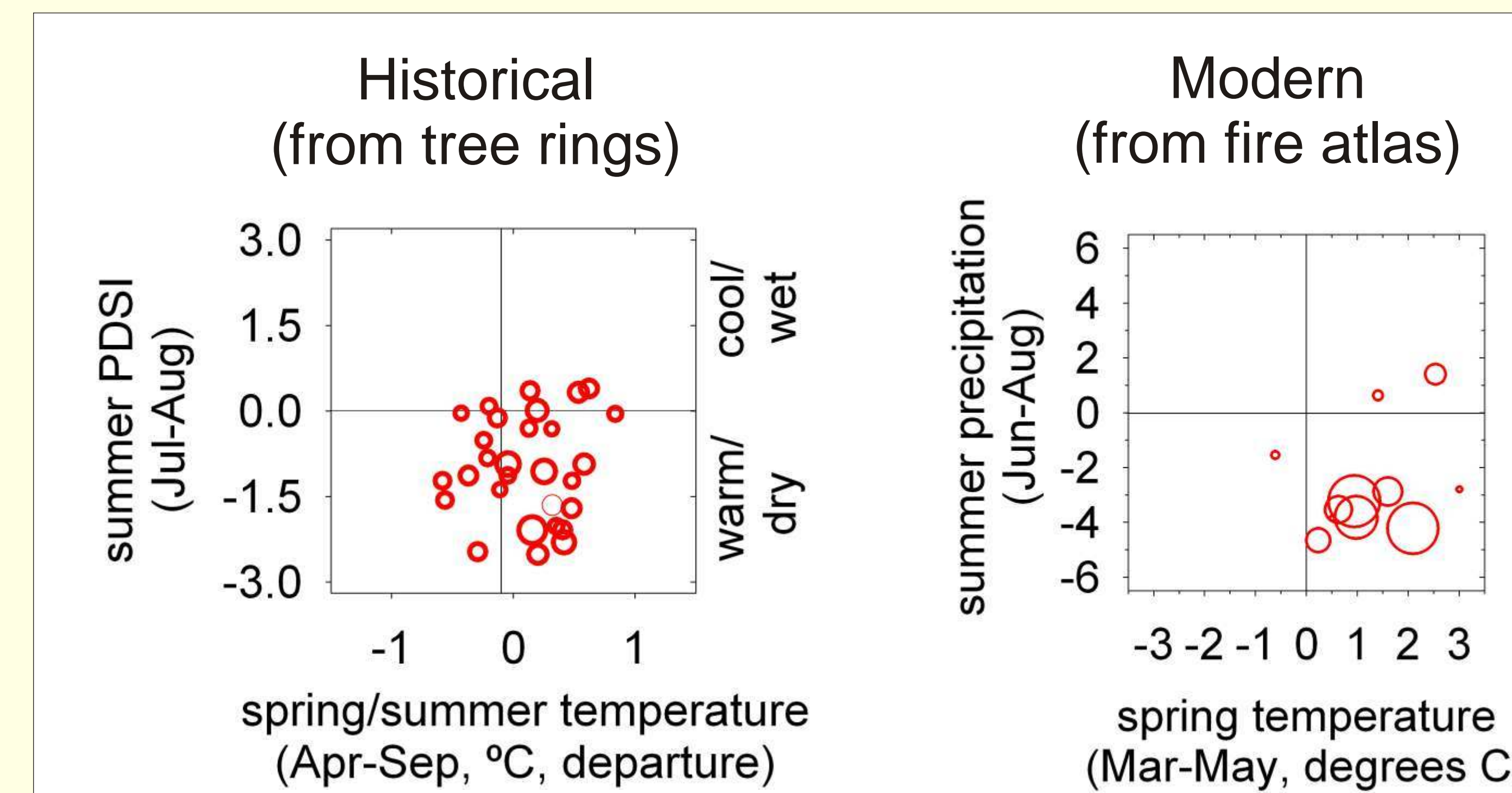


Figure 5. Interaction between spring and summer climate for historical (left) and modern (right) regional fire years. Circles are proportional to the degree of synchrony (25 to 57% of sites for historical fires and 81 ha to 1,167,458 ha for the fire atlas)